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AUTHOR Span, Pieter
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ABSTRACT

Witkin's concepts of field dependence-independence and restructing are discussed with reference to studies in Russia and in the Netherlands. These concepts are related to differences in style of perception and to success on both cognitive tasks and social tasks. It is suggested that restructing abilities may be trained and restructing ability may influence different aspects of learning. An experiment is summarized in which subjects reported their introspections while working on embedded figures tasks. Russian studies of perception are discussed and it is suggested that perception develops through several stages or levels. A pilot study with 30 children is described, but it was concluded that the tasks that were set did not accurately represent the actual order of perceptual development in the children. A question is raised as to whether perceptual development as indicated by embedded figures tasks was really a single dimension of ability. The concept of individual differences and the concept of individuality are compared. (CTM)

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RE-STRUCTURING AS A COGNITIVE TASK

Pieter Span*
I.P.A.W., Heidelberglaan 1
University of Utrecht
Utrecht, The Netherlands

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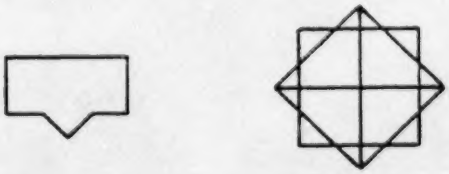
In 1950 Herman Witkin published an article, which has become a classic: "Individual Differences in Ease of Perception of embedded Figures". Using figures, created by the German Gestalt psychologist Gottschaldt, he designed test materials in which the subject has to locate a simple figure in a complex pattern. This task is quite difficult, because the simple figure is *embedded* in the complex one.

Figure 1: An item of the Embedded Figures Task



Witkin found considerable inter-individual differences in achievement: time necessary to solve the 24 items ranged from 2 to 70 minutes. Witkin interpreted the ability, measured by his Embedded Figures Test-task in terms of his theory on *Field-dependency - Field-independency*. A quote from his 1954 book: "To determine whether a given degree of ability to deal with an item independently of its surroundings is a pervasive characteristic of a person's perception ...". Field-dependent persons are persons whose perception of the part is strongly affected by the surrounding field. Field-independent persons are able to detach themselves from the impact of the field and to deal with the part as a more or less independent unit.

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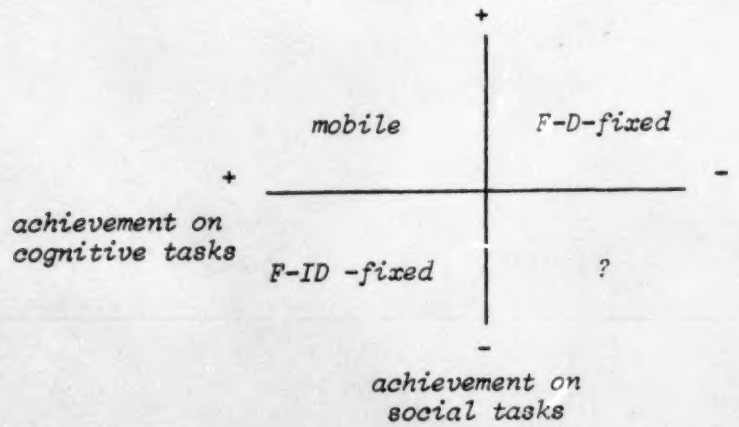
From the retrospective reports of his subjects Witkin inferred that persons with a "good" score use an *analytical approach* to solve the problems. The subjects with a "bad" score, are, still according to Witkin, strongly influenced by the structure of the complex design as a whole, and are not able to enter upon the necessary analysis of the complex design. The differences in achievement can be interpreted, according to Witkin, as a difference in *style of perception.*

In the next 25 years the concept of style of perception evolved to the more general concept of *cognitive style* - partly because EFT-scores correlate with scores on problem-solving tasks of Duncker and Guilford and with sub-test-scores of the W.A.I.S. - and later to *style of adaptation.* Cognitive style has to be looked upon as some adaptation of a psychological system to the environment. Certain people may prefer, in different situations, the same style of adaptation (field-dependent or field-independent); other people may process information in different ways relative to the kind of situation to which they have to adapt. The latter are characterized by Witkin as *"mobile"* - they have access to the characteristics associated with both styles -, the former are called *"fixed"* (Witkin & Goodenough, 1977).

Notable was, for instance, that field-independent persons achieved very well on cognitive tasks but less well on certain social tasks; the reverse held for field-dependent persons. We may visualize these findings as follows:

Figure 2: A model of Adaptation Styles



Very few proposals to operationalize the social tasks have been made till now; the EFT is, in this conception, only a very efficient example of potential cognitive tasks. However, if someone prefers a certain style of adaptation, it is necessary that he has the involved abilities to his disposal. In this case: both cognitive and social abilities. As just mentioned: as an instance of the cognitive tasks one has taken the EFT; the ability measured has recently been called *re-structuring ability*.

Now, if one wishes to improve the re-structuring ability, one has to decide for *training*: to incorporate it in regular curriculum or to construct special courses. In both cases we have to answer the same question: how can we improve the re-structuring ability? To answer this question, we first have to solve yet another problem: what exactly is re-structuring?

In re-structuring tasks persons are confronted with well structured complex designs, which have a *Gestalt-quality*. To locate the simple figure one has to detach oneself of the Gestalt quality of the patterns. The first impression of the complex design has to be placed in the background, so that a certain, embedded, part of the design may come to the foreground. The old *figure-ground relation* is replaced by a new one. Re-structuring ability is the ability of a person to break through the initially perceived figure-ground relationship through analysis of the perceived structure in reference to a standard figure.

Of great importance is the finding, that the ability measured by the EFT has some resemblance to the way in which information has to be organized in apparently different tasks. On the AERA-conference last year, J. Kent Davis (1979) handed out a table with correlations between EFT and reading ability.

Table 1: Summary Statistics by grade level of the correlations between EFT-measures and reading ability

grade	*n. of studies*	*median*
1	9	.54
3	3	.41
4	7	.41
5	2	.46
6	11	.30
9 - 12	4	.40

Up till now no definitive explanation for the relatively high coefficients has been offered. In my opinion they indicate that re-structuring is an individual difference variable which influences different aspects of learning.

Another striking relation was found by Spiro and Tirre in their well-known restaurant-supermarket experiment (1979). From the supermarket story subjects with a good performance on the EFT remembered as many food-items as the subjects with a bad performance. From the restaurant story the "good" subjects remembered significant more food-items than the "bad" subjects. In the restaurant case *"schema-utilization"* was possible. To quote the authors: "Analogously to the EFT, one must detect the relevance and applicability of pre-existing knowledge schemata and superimpose those structures on the text in interaction with the text's inherent structure" (p 10.).

In general, if we want to know the reason for the variability in, for instance, EFT-scores, we have to gain insight in the *cognitive processes* of subjects who are acting different by Embedded Figures tasks.

In the early seventies I did some research with the EFT (Span, 1973). The analysis of the systematic intro- and retrospection of subjects and the factor analysis of EFT-scores and scores of so-called marker-tests gave the following results. The initial activities may be characterized as a global and imcomplete survey of the simple figure and the inability to structure the complex design in different ways. In the next phase the subject is able to break through the Gestalt in the complex design, whereupon the subject in a systematic way locates the marked part of the simple figure - which he has encoded in memory - in the complex design. If he has located this detail, he will try to complete the simple figure in the complex pattern. In the third phase the subject can keep in mind the simple figure as a whole while looking for this figure in the complex design. Because he has no trouble with the Gestalt quality of the complex pattern, the simple figure he has "before his eyes" coincides with the hidden figure in the complex pattern. He sees the hidden figure at a glance. There is no question of building up the parts of the simple figure; the re-structuring takes place at once. A new figure-ground relationship has been formed in an instant.

In view of the aforementioned development in style aspects of perception it was a stimulating experience to read about the theory of the Soviet psychologist Zaporozhets (Cole & Malzman, 1969). Zaporozhets stated that perception serves as the central function in the development of the young child. As a dedicated pupil of Vygotsky, he studied the development of perception from Vygotsky's point of view. Especially that the higher mental functions (the intra-psychic ones) originate from and build upon social activities (the inter-psychic functions). Since perception is established through elaborate learning processes, (goal-oriented) instruction is of first importance: "Soviet pre-school educational theory ... regards sensory development as the development of new processes and abilities that the child does not have at birth but which he acquires under the influence of an active program of instruction" (Zaporozhets, 1969, p. 89).

This statement opposes the view of Gestalt psychologists who insisted that integrated impressions arose spontaneously. The essential difference between Zaporozhets and Gestalt psychologists is the amount of involved activity, on part of the individual, in the development of perception. Perception requires purposive actions. The development of perception and the development of *perceptual actions* are identical. Perception is marked by its *exploratory or orienting activities*. In the acts of the perceiver an object is oriented on, the object is charted. The individual incorporates characteristics of the object, so that he may act on part of this representation. That is why the perceiver has to be active. Only those characteristics are made part of the representation that will be necessary for consecutive acts with the object.

Zaporozhets distinguishes several stages in the development of a representation. Initially the object is manipulated in a random fashion. Trial and error so to say. Unintentionally a successful act is completed. Within this act an *orienting* and an *executing* part differentiate. In the orienting part the object is scanned for (goal)-relevant information on the subject. This orientation is still completely externalized. The child builds up a *motor image* of the object. These motor patterns, acquired by handling the object are of a different nature than representations formed on the basis of eye movements. Venger, one of Zaporozhet's pupils, puts it: "We can conceive of the earlier forms of perception as forms that

utilize sensory-motor "prestandards" or "templates" derived from material motor acts adapted to the properties of objects" (Venger, 1977, p. 398). In the next stage hand movements are replaced by eye movements. The image loses its motor character, gains a perceptual character. Because of its increasingly perceptual character more and other characteristics of the object may be incorporated into the image (form-details, color for example). Newly formed perceptual acts are most *elaborate*, in due course they are *shortened* more and more. This process may lead to orienting perceptual acts at a glance: "Education must provide ways in which the child will successively master a system of conventional standards of sense data. He is told how to use these effectively to analyse and synthesize the qualities he perceives in surrounding objects. This use of standards requires that in addition to a knowledge of sensory patterns (...elementary forms etc.) a child be able to compare these qualities in real objects; that he is also able to detect other relationships between the parts of the objects" (Zaporozhets, 1969, p. 92-3).

As you may understand, I have described the perceptual development only sketchily. For instance the transfer from manual to perceptual orientation; that is a most delicate process. Not only does the hand lead the eyes, the eyes lead the hand. Verbal acts may come to accompany part of these processes; if so they will attain a planning function for the orienting perceptual act.

An exact description of the development of perception may offer, as an huge advantage, a basis for the construction of diagnostic tests for both the actual and potential zones of perceptual development and for the construction of training programs. Training programs to accelerate development or to break through halting progress.

From the above and related statements one could conclude the Embedded Figures Task to be a prototypical task that is excellently suited as a diagnostic task for the actual stage of perceptual development.

The construction of such a test is a difficult undertaking. First, we have to distinguish within, and build in, the test the various *levels of action*. For this purpose we aim at a qualitative diagnosis; an achievement score as for instance the EFT yields, is inadequate. Given the distinguished levels, we have to present the test material in a specific way, with an instruction that may be interpreted in accordance with these levels.

Therefore the levels of development have to be *operationalized*. Second there is the problem of *scoring*. We have to "translate" qualitative levels into quantitative scores. We will elaborate upon this matter now.

We agree with Venger that quantitative measurement is necessary. There will be differences with regard to actions between children at each level of development. The classification in 3, 4 or 5 levels is rather coarse-grained. Another argument is, that perceptual actions can only be brought out in the open through concrete tasks. Success on a task does not only depend on the level reached, but also on other (chance) circumstances. The relation between cognitive activity and solving a problem is not an absolute one, but *probabilistic*. Statistical methods will have to partial out the variance caused by uncontrolled factors. With regard to the actual zone of development this is not a simple task, with regard to the potential zone of development is is even more ticklish. With these considerations in mind we are able to explain why Soviet Russian psychologists (Kalmykova, Ponomarev, Venger) up till now did not succeed in constructing tests in the true sense of the word. (Hence, Brown (1979), in her excellent paper on intelligence testing in the year 2000, states, that Soviet psychologists gather valuable information by estimating the width of the zone of potential development, yet their descriptions are notable for their lack of specificity.)

Now, if we want to construct a test that pretends to measure levels of development, we have to prove that it is a matter of *one dimension* (trait) only and that the data obtained are *ordinal*. If we want quantification, we have to fit the data in a *structure of numbers*. If we give scores in an intuitive way, that is no matter to be looked upon as objectivity, but as pseudo-objectivity only.

After years of (intelligent and diligent) trial and error, we are now experimenting with the following test-procedure. We assume that in the embedded figures task:

level of perceptual development ← orienting activity ← conditions such that the S. solves the problem

We now try to determine the level of development by presenting to the child successively - from difficult to easy - the conditions that operationalize the various methods of problem solving resp. ways of orientation. The child is not free to choose, he is forced to demonstrate his "real" actual level of development, he is not tempted to function at a lower level than he is able to.

The testing procedure begins with a detailed introduction; the child is informed with help of a specimen of the task about the various conditions (Appendix I). After that 8 items are presented successively, first on the highest level, than on the next lower, etc., till the child solves the problemn. An abstract of the levels is presented in table 2 (p.9).

Recently we did a pilot-study with 30 children: 10 with an average age of 5.6 years; 10 of 6.6 and 10 of 7.6. The main points of interest were:

1. If developmental improvement goes together with the use of problem solving methods of a higher level, we can expect that older children will have more success with solving methods of a higher level than younger children.
2. Are the chosen conditions, the operationalizations of the various levels of problem solving adequate?

Table 3 shows the number of times the children solve the problems at a certain level (A up to and including E), separately for the three age-groups.

Table 3: Frequency of solutions per level per age-group

N	Age	A	B	C	D	E
10	5.6	0	6	9	49	16
10	6.6	15	16	12	33	4
10	7.6	15	25	14	19	7

Table 2: Levels of perceptual Development

level	*orienting activity*	*level of processing*	*conditions such that the S. solves the problem*
A	shortened, interiorized orienting activity	simultaneous perceptual processing	- "passive" attitude - SF not visible - time limit 5 sec.
B	elaborate interiorized orienting activity	successive perceptual processing	- active attitude - SF visible - analysis of SF - systematic search in CF
C	materialized orienting activity	successive materialized processing	- active attitude - analysis of SF with the aid of sticks, sticks represent certain characteristics: position, direction, length - idem of CF
D	manipulating activity		- manipulate transparent SF - trial and error
E		problem not solved	

In the table you will see that the level increases with age. If you look from upper right to bottom left the same tendency is apparent. However, strikingly few children acts on level C.
Individual analyses and analyses per item show that the development does not take a course from D by way of C to B. We suspect that the proposed level C-materialization is not correct.

Right now we are looking for alternative approaches. We think that under present instructions fitting and measuring are activities in their own right instead of orientation means in order to attain another goal. That is the task that confronts us now. If we succeed in finding a more adequate materialization, we will try out on another sample in order to establish the ordinality of the levels the unidimensionality of the test and the feasibility of converting these qualitative accomplishments into a numerical structure. Traditional test theory is lacking in this respect so we will have to turn to alternatives such as Fisher's (1974). *probabilistic latent trait theories.*

In classical test theory a person's score is a direct manifestation of a particular underlying ability (trait/characteristic).
The association between test-score and trait is deterministic and unconditional. Such a test score is an approximation of a person's "true score". This line of reasoning also goes for the EFT.
In latent trait theories test behavior is a manifestation of the underlying ability, yet that ability may not be observed directly, it is latent. Test behavior is one indication only of the latent trait. The test constructor or test-user is to indicate what the observed behavior implies with regard to that assumed attribute. He is to specify how the latent trait is best objectified. One has to make it one's object to develop a *model,* a body of assumptions, that enables one to indicate the relationship between test behavior and trait. Once a model is available you may test whether the acquired data fit in the model. (We shall not elaborate upon the technical details of the underlying *unidimensional polychotomous logistic model* by Rasch).

The data of the above mentioned experiment have been collected in such a way that they fit the demands of the latent trait model. We are not able to test it yet, since category C data have not been operationalized correctly.

Moreover some items have to be changed, samples of several hundreds of subjects are required and the necessary computer programms are still to be implemented.

More important than all, that we are to doubt a fundamental tenet: May perceptual development with regard to embedded figures tasks be conceptualized as one dimension only? Over and over again factor analytic studies led to a 2-factor structure. Thurstone called them in 1944: *"flexibility of closure"*and *"speed of closure"*. So did Carroll in his 1976 "New structure of intellect" with the factors Cf and Cs as cognitive processes (1976, p48). The underlying, latent, trait for levels D, C and B could be flexibility of closure; with speed of closure underlying A. We can not exclude the possibility that level A subjects orient themselves in a fundamentally different way. In that case quantitative measurement is impossible. All we can do then is indicating the number of times that individual subjects solve a problem at each of the levels. Possibly our aims are over-sophisticated, that the various levels of activity can not be measured in the strict sense we intended to.

On the other hand it seems incorrect to simplify the tasks. We do believe that the very complexity of the EFT-task taps what levels of perceptual activity stands for. Now you may ask me, why these levels, why these instructional conditions? Well, it works. We used parts of the "test" just described as a pre-test and post-test in a training-investigation. For each level the tasks were broken down into its components. School materials were used to train pupils in the various constituing tasks of the consecutive levels. The post-test showed the effects of the entire procedure. Results that fit work in the U.S.S.R. We are still to show that these specific geometrical materials lead the person to develop cognitive strategies that are as useful with completely different materials such as in reading or in remembering texts.

It has been shown, however, that such training is effective that is based upon a theory on the development of perception, in which levels are described in terms of activities with specified materials. We apprehend that quantitative measurement of levels will not be feasible. This preliminary conclusion may be of some importance for the future activities of Brown (1979). I quote her because her work is partly similar to what I have just told you.

"Another potentially illuminating testing procedure would be to consider individual performance before and after experiences intended to uncover zones of potential development, experiences that could include supportive adult/child cooperation, and group acctivities. We are currently initiating a program of research to examine the feasibility of such an approach. By the year 2000, we may have a battery of techniques for considering the situational specificity of cognitive competences and the learning potential of individual children. Armed with such information we should be able to form a far more balanced picture of the child's capabilities than can be revealed by his score on standardized tests" (p.22).

In conclusion some words on *individual differences* and *individuality*. With Markova we want to tell these concepts apart. Differences between persons could refer to differences in development caused by situational influences, like differences among schools or education at home. Up to a certain extent such differences may be minimalized by means of good instruction. Good instruction is to be understood here as *"guided"*. Investigations show that as schoolinstruction is less and less guided more and more differences between persons are found. Hence Soviet Russian psychologists conclude: *early, much* and *guided* instruction. The child doesn't find his own way, the psychologists have found the most adequate way. Individuality is reffering to a personal choice from the aggregate of abilities one has at his disposal. Such a conceptualization is akin to Witkin's concept of style: Incoming information is processed differently depending on the setting in which it is met. The boundaries of the style are determined by the strenght of a person's abilities. The ideal in this model is the really "mobile" person.

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